Effect of Students' Anxiety on their Achievement in Mathematics at Grade X in Punjab

Rana Qummer Hussain

Subject Specialist, Mathematics, Punjab Workers Welfare Fund Lahore and
PhD Scholar at Department of Education, Bahauddin Zakariya University, Multan

qummerhussain110@gmail.com

Professor Rana Muhammad Dilshad

Department of Education, Bahauddin Zakariya University Multan,

dilshad@iub.edu.pk

Abstract

The purpose of this study was to explore anxiety and achievement in mathematics of the students at secondary level in Punjab, Pakistan. Study was descriptive in nature and survey method was considered for data collection. More than nineteen hundred students participated in study. Two types of tools were administered for quantitative data collection Achievement Test and Mathematics anxiety scale. After data collection frequencies, means and standard deviations, t-test and ANOVA were calculated. Correlation of mathematics anxiety with the achievement of the students was calculated. Gender wise locality wise, area wise and sector wise analysis was done. The achievement score of male female students, rural and urban students, public and private school students were also compared, and findings were made accordingly. It was concluded that achievement score was less where anxiety was more and vice versa. Anxiety was dominant in male, urban and public sector students. Achievement score was prevailing in female, rural and private students. It is recommended to arrange refresher courses for the teachers, establishment of mathematics labs and regular visits to industrial areas for practical applications of mathematics.

Keywords: Mathematics Anxiety, Achievement, Science and Technology, STEM fields,

1.   INTRODUCTION

Mathematics has capability to integrate whole from the part (Emanet, 2021). Numerical problem solving education have attained special importance in the field of science technology (Hassan, Gimba, & Chado, 2016).Pakistani education system has multiple levels higher secondary, secondary, middle and at primary from nursery to intermediate (Ciss, 2019). Numeric fluency and applications of mathematics cover all fields of life including Agriculture, medicine and space technology (Hodanova, 2016). Weak conceptual back ground in arithmetic operations is main cause of low interest of students in science and technology subjects (Gimba, Hassan, Yaki, & Chado, 2018). Companies and firms recruited their employees from all communities without discrimination of race and color (Shrestha & Heisler, 2011). Basic calculation knowledge is necessary for the problem-solving capability among students (Hamidah, 2022). Quality education in mathematics produce skilled workforce for science and technology (Hodanova, 2016). Ability to learn mathematics is

different for individuals (Virgana, 2019). Teachers' prior knowledge regarding use of technology is proved to be very helpful while teaching modern skills related to digital skills (Hirsh, 2020).STEM fields means the fields related to science, mathematics, engineering and mathematics (Koonce, 2011).Mathematics is language of symbols and have attained universal identity to solve real life problems (Parker Waller, 2016).Poor result of mathematics can influence overall result of the students (Bramlett & Herron, 2009). Weak concepts or negative class room experience of students in junior classes resulted in reduced number of students in higher classes (Amer, 2017).Students which are unsatisfied in mathematics classrooms develop mathematics anxiety (Rameli, et al., 2014).There is inverse relationship between mathematics anxiety and achievement of students (Rizwan & Mahmood, 2010).

1.1   Rationale for the Study

Mathematics is language of science and technology (Bosman, 2018). Basic numeracy skills play major role in providing services to society (Cemen, 1987). Basic proficiency in mathematical skills can be helpful to engage students for modern knowledge (Bhatnagar & Saxena, 2000). Uneven learning process and environment develops anxiety (Bursal, 2006). Poor achievement in calculation is a great problem (Cohen, Ibrahim & Allen, 2017). Poor understanding of mathematics cause mathematics anxiety (Mangi & Hussain , 2018). Stake holders in developed countries have done good efforts pre-service trainings of pedagogy, technology standards, students monitoring and evaluation (Hirsh, 2020).In Pakistan students feel anxiety in solving mathematics problems related to Algebra, Analytical Geometry, Trigonometry, and word problems (Naveed, 2016). Some administrative factors are also involved which limit achievement of students in mathematics (Naveed, 2016). For optimistic and operative classroom involvements development an e-learning system which can facilitate mathematics students to address the misconceptions in basic mathematics (Amer, 2017).

1.2   Objectives of the Study

The following objectives were developed for the study:

1.   To compare students' anxiety and achievement in mathematics of students by gender (male/female), locality (urban/rural), and type of the school (public/ private).
2.   To suggest measures to reduce anxiety.

1.3 Research Questions

Consistent with the objectives, the study was driven by following research questions:

1.   Do the students feel mathematics anxiety?
2.   Is mathematics anxiety accountable for affecting achievement of students?

1.4 Statement of the Study

Economic growth of developing countries depend upon mathematics fluency of the students (Anyamene, 2022). Teachers are practicing outdated ways of teaching mathematics (Ali, 2010). Students and teachers need to read, write, and speak about mathematics and its symbols (Sheerazi, 2000). Basic numeracy skill can mature critical thinking of students for solving real life problems. (Ali, 2010). Calculation fluency can be used to develop critical thinking (Dowker, 2016).Number of problems are still to be addressed in Pakistan, like deficiency of teacher's trainings, non-utilization of mathematics software, lack of human and material resources, overcrowded classrooms, lack of interest of students and teachers, very rare students' visits of industries to see applications of applied mathematics (Naveed, 2016). Less use of modern technologies and above stated factors create anxiety and reduce achievement of students in exams (Margoum, 2022).

1.3   Review of Related Literature

Mathematics anxiety is a feeling of fear, nervousness, tension in performing various mathematical operations (Cemen, 1987). Problem solving method can increase achievement and decrease anxiety (Rizwan & Mahmood, 2010).Negative experience in mathematics class room give rise mathematics anxiety among students (Rameli, et al., 2014). Mathematics

anxiety might be a factor in the selection of friends, students with mathematics anxiety get close to those who helped these students (Kesici, 2019).Student-centered teaching practices had a positive and significant effect on the student's mathematics achievement (Emanet, 2021). Misconceptions in one lesson of mathematics can affect other lesson, this raise difficulty level of next lesson so mis concepts in lessons needed to be addressed at once. Misconceptions or low understanding of concepts in mathematics hinder mathematics learning of student and become a factor of mathematics anxiety (Amer, 2017).Teaching strategies and uncontrolled learning environment create mathematics anxiety (Atoyebi, 2022). High mathematics anxiety at middle standard hinders in taking mathematics higher grade (Virgana, 2019). Tutors and mentor can play a key role in reducing anxiety of the students through modern ways of delivering knowledge to the students. (Rizwan & Mahmood, 2010). Rigid approach of the teacher can increase mathematics anxiety of the students (Mangi & Hussain , 2018).

 Rote memory reduces active participation of the students in mathematics class rooms and using refrain students from building new concepts (Emanet, 2021). Many pre-service teachers brought some experience with technology into institute which may include word processing, gaming, and social media (Hirsh, 2020).Quality teaching can reduce mathematics anxiety (Hodanova, 2016).

Weak background of math teachers enhances anxiety of the students (Gimba, Hassan, Yaki, & Chado, 2018). Numeracy unease can affect every aspect of one's life (Kesici, 2019). Addition of daily life problems in mathematics curriculum reduce cramming support critical thinking among the student's (Reys, Lindquist, Lambdin & Smith, 2007).Progressive, tension free and friendly environment should be created by mathematics teachers for reducing student's anxiety in mathematics (Atoyebi, 2022).Teacher could facilitate shortest solution procedures (Sheerazi, 2000). Proper use of technology can resolve misunderstanding (Amer, 2017). Trained teacher produced good achievement score or students (Vania & Xin, 2014). Educationists have recommended to make education need based for society (Margoum, 2022).

1.4 Effect of mathematics anxiety (MA)on achievement of students

Student's working between nations is important (Suter, 1991). Aachievement of secondary school students was negatively affected by mathematics anxiety (Bhatnagar & Saxena, 2000). Student-centered methods are much better than traditional in reducing mathematic anxiety (Emanet, 2021). The teachers having mathematics concern will transmit their nervousness to students (Mangi & Hussain , 2018) . Students with unclear concepts, poor results and high mathematics anxiety start avoiding mathematics (Adeyemi, 2015).

1.5 Symptoms of mathematics anxiety

Indicators of mathematics anxiety are; Uneven heartbeat, lack of retention, fade in color, upset appearance, fear of failure, unexpected change in blood pressure, feeling drained, and trembling and avoiding to face and solve problems (Kumari, 2015).

1.6 Damages/ Losses done by of mathematics anxiety

Physical and psychological stresses damaged health and also dropped achievement score in examinations. (Preis & Biggs, 2001). Rigid behavior of teacher cause drop out of the students (Mangi & Hussain , 2018).

1.7 Ways to address/ reduce mathematics anxiety

Mathematics anxiety can affect directly or indirectly (Emanet, 2021). Administration   should manage workshops, training sessions and visits to industry to see applications of mathematics in daily life (Gimba, Hassan, Yaki, & Chado, 2018). Mix methods of teaching supported with modern technology can reduce anxiety (Kesici, 2019). Use of new technologies can raise quality of education (Margoum, 2022).

Mathematics anxiety of the students can be addressed by avoiding to call shy students on

board, arranging suitable groups for students, promote hands on activities, practice, use low cost or no cost material (economic/ Cheap), Appreciation (Cohen, Ibrahim & Allen, 2017). Collaborative teaching technique, discussion boards, availability of material or technical sourcesfor rich or poor student, Study trips and meeting with alumni (Mangwende, 2020). Practice makes a man perfect, so with good motivation regarding mathematics goals student can be fluent if student can make excessive practice of basic mathematics concepts (Sheerazi, 2000). As described by (Forbinger & Fuchs, 2014), "*Fluency is the ability to find an answer quickly and effortlessly, either because the answer is memorized or because the individual has developed an efficient strategy for calculating the answe*r" (Forbinger & Fuchs, 2014, p. 54). Use of calculators slows down mathematics fluency among the students (Forbinger & Fuchs, 2014). Clear concepts increase fluency in mathematics. (Forbinger & Fuchs, 2014).

METHODOLOGY

For this study survey method was employed to collect the required data. The quantitative method was a positivistic. (Sinaga, 2022). Fazal used five-point Likert scale form to test math's fear as a study tool and used quantitative technique with multiple regression model for finding the relation of mathematics anxiety and academic performance (Fazal-ur-rehman, 2022).

3.2 Research design

Quantitative method was adopted for the current research study. After literature review tools were adapted i.e. Mathematics anxiety scale and achievement test. These tools were administered by the researcher himself in six districts of Punjab.

Research instruments

Research had two tools i.e achievement test and mathematics anxiety test. Researcher conducted quantitative study by collecting data from the students. After pilot study and knowing difficulty index of items some items were replaced. For the convenience the tools were translated in urdu also in order to remove language barrier. Data was collected and processed and after analysis, results and conclusions were made. Suitable suggestions were also made on the basis of study for future research.

Tool -01 Mathematics anxiety questionnaire for students

Mathematics anxiety Questionnaire (MAQ) adapted from DIANA K. MAY (2007) under the direction of Shawn and denise. This tool contained sixteen items related to mathematics anxiety.

Sr. No.	Factors	
1.	: Stress	
2.	: Trauma	
3.	: Sleep Deprivation	
4.	: Medical condition	
5.	: Uncertain Changes	
6.	: Genetics	
7.	: Environment	(Naveed, 2016)

TABLE OF SPECIFICATION FOR ACHIEVEMENT TEST 2021

Chapter No.	Name	MCQ's Items in test	Weightage
01	Quadratic Equations	07	14%
02	Concept of Quadratic Equations	07	14%
03	Variation	07	14%
04	Partial Fraction	07	14%
05	Sets and Functions	07	14%
06	Basic Statistics	07	14%

07	Introduction to Trigonometry	08	16%
	Total	50	100%

Table of Specification for

ACHIEVEMENT TEST Grade 10

- 01 Quadratic Equations
- 02 Concept of Quadratic Equations
- 03 Variation
- 04 Partial Fration
- 05 Sets and Functions
- 06 Basic Statistics
- 07 introduction to Trignometry
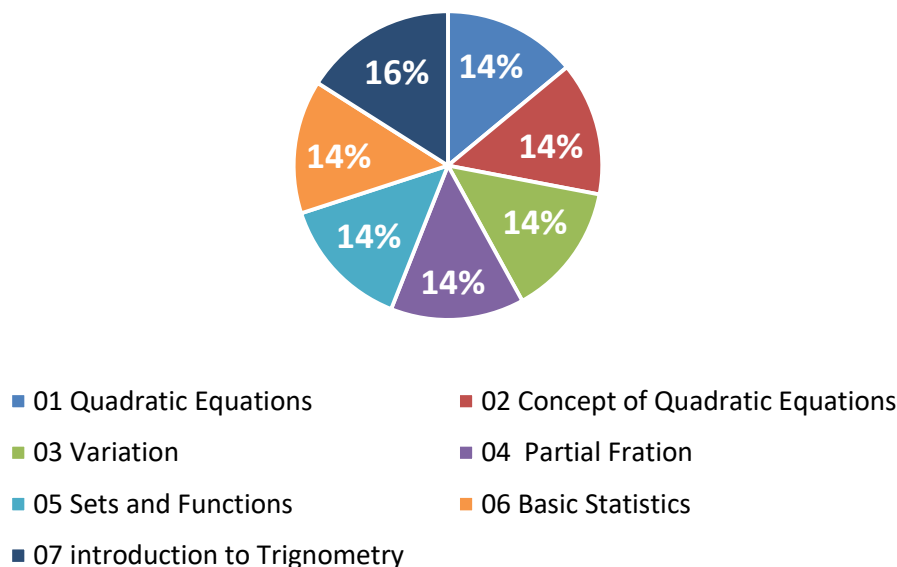
Tool -02 Achievement Test for Students

The achievement test comprised of fifty objective type items, validated from subject specialists and subject experts. Initially seventy items were taken but after pilot study twenty items were exclude from test. This test was administered on students of grade X.

Population

All the 10th class male / female students belonging to public/ private and urban/ rural areas of Punjab were taken as population.

Target Population

Only six districts were considered in target population for study, these10th class male / female students belonging to public/ private schools with residence of urban/ rural areas of Punjab were taken as target population.

Sr. No.	Board	Students Appeared in 9th 2019 Exams.		
		Public Schools	Private Schools	Total Students
1.	All Boards total students			11,06,478

Ciss data of Boards

(Iqbal, 2019)

Sample

A sample of one thousand nine hundred twenty students were taken from selected districts studying at secondary level.

Sampling

Research with a sample of 300 students by using multistage cluster random sampling

[273]

technique (Khaliq, 2016).Form the Target population sample was taken through multistage sampling technique. Whole Punjab was divided into three regions namely Upper Punjab, Lower Punjab and Central Punjab.

2.1 Data Collection
There were 36 districts of Punjab in these three regions. Only two districts are taken from each region through convenient sampling. Then from each district 16 schools, eight from urban area and 08 from rural area, out of these 08 schools 04 were boys' schools and 04 were girls' schools.

Gender wise and public private data collection scheme for rural and urban schools

Urban School students				Rural Schools students				Total Schools in one District
Public		Private		Public		Private		
Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	
02	02	02	02	02	02	02	02	16

Gender wise scheme of data collection

Total schools in Six Districts = 96
No. of students from each school   = 20
No. of students one District   = 16 x 20 = 320
No. of students in six districts = 320 x 6 = 1920

Student wise and public private data collection scheme for rural and urban schools

Urban				Rural				Total Schools in Six Districts
Public		Private		Public		Private		
Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	
240	240	240	240	240	240	240	240	1920

The district's schools were drawn on convenient basis; however, the selection of the students was made based on simple random sampling.

3.   RESULTS AND DISCUSSION
Sector/ type wise correlations between mathematics anxiety and achievement
N=1920, Public   =960, Private =960

		M		SD		r		Sig.
		Public	Private	Public	Private	Public	Private	
01.	Math. Anxiety	2.54	2.47	.64	0.69	-.15[**]	-.17[**]	0.000
02.	Achievement Score	31.67	35.9	11.08	10.65			0.000

Mathematics anxiety score for public and private schools was significant. Mean anxiety score was dominant in public schools. Achievement score was significant and dominant for the private schools.

Correlations between rural and urban students' mathematics anxiety and achievement

N=1920 Male =960 Female =960	Mean		S D		r		Sig.
	Urban	Rural	Urban	Rural	Urban	Rural	
01. Math. Anxiety	2.52	2.49	0.67	0.67	-.19[**]	-.15[**]	0.000

02. Achievement Score	33.52	34.08	10.95	11.20			0.000

Mathematics anxiety score for urban and rural schools was significant. Mean anxiety score was dominant in urban schools. Achievement score was significant and dominant for the rural schools.

Gender wise (male and female) students' correlations between mathematics anxiety (MA)and achievement

N(Total)=1920. N(Male) =960, N(Female)=960

Variables	M		SD		r		Sig.
	Male	Female	Male	Female	Male	Female	
01. Math. Anxiety	2.53	2.48	0.71	0.63	-.20**	-.14**	0.000
02. Achievement Score	33.25	34.34	10.24	11.84			0.000

Mathematics anxiety score for male and female schools was significant. Mean anxiety score was dominant in male schools. Achievement score was significant and dominant for the female schools.

Mean score of mathematics anxiety of the students indicated presence of moderate level of anxiety. Highest and lowest anxiety score showed that students included in this study were suffering from mathematics anxiety.

 For mathematics anxiety of public and private students' responses both groups shown moderate level of anxiety, but anxiety level of   the private school students was less as compared to the public-school Students.

Through one way ANOVA it was known that difference was not significant in all districts except DG Khan and Bahawalpur responses, where difference was significant. Moreover, anxiety level of the D.G. khan students was higher as compared to Bahawalpur students. As difference is significant so results lead to regression analysis.

Comparison of male and female students' achievement showed that there was significant difference between the achievement score of the male and female students. Moreover, the achievement of the female students was high as compared to the male students. There was found no significant difference between achievement score of rural and urban students. However, the achievement of the rural respondents was positive in comparison to urban respondents.

Correlation of math anxiety and achievement for male and female score illustrates that for both groups the correlation was negative, which indicated that achievements of both groups was affected by mathematics anxiety. Although both correlations were weak and negative, yet achievement score of male students showed that mathematics anxiety (MA)had more negative affect on male students.

Correlation of math anxiety and achievement Score of rural and urban illustrates that for both groups the correlation was negative. Although both correlations are weak and negative, yet achievement score of urban students seemed that mathematics anxiety had more negative affect on achievement of the Urban students.

Correlation of math anxiety and achievement score illustrates that for both groups the correlation was negative. Performance of the private students were Better.

Regression analysis between achievement score in mathematics and mathematics anxiety score of the respondents. Results revealed that the mathematics anxiety affected achievement score. Effect of mathematics anxiety on achievement was significant.

2.   CONCLUSION

It was concluded that achievement score was less where anxiety was more and vice versa. Anxiety was dominant in male, urban and public sector students. Achievement score was prevailing in female, rural and private students.

3.   Recommendations

It is recommended to arrange refresher courses for the teachers, establishment of mathematics labs and regular visits to industrial areas for practical applications of mathematics

1.   In future researches work load of mathematics teachers should be analyzed.
2.   Text Book content of mathematics book and time of session may be analyzed.

4.1 Delimitation of the Study

Having limited time and resources, the study was delimited to,

1.   Only six districts of the province, Punjab, Pakistan.
2.   Only students of 10th Class from matric or SSC class.
3.   Only students who opted mathematics of science group in matric (Grade X).
4.   Maximum 20 Participants from each school were taken, even if school had more than 300 students in 10th grade.

REFERENCES

Vania & Xin. (2014). A comparative analysis of the relationship between learning styles and mathematics performanceA comparative analysis of the relationship between learning styles and mathematics performance. *International Journal of STEM Education, 1*(1), 1-13.

Adeyemi, B. (2015). The efficacy of authentic assessment and portfolio assessment in the learning of social studies in junior secondary schools in Osun state. *Ife PsychologyIA, 23 (2)*, 125-132. Retrieved August 21, 2019

Ali, R. (2010, February). Effect of Using Problem Solving Method in Teaching Mathematics. *Asian Social Science, 6 (2)*, 67-72. Retrieved August 2019

Amer, M. A. (2017). E-learning application to teaching mathematics. *International Journal of Management and Applied Science, 3*(9), 81-90. Retrieved from http://iraj.in

Anyamene, A. O. (2022). Relationship between Learning Styles and Mathematics Academic Achievement of Secondary School Students in Awka Education Zone. *International Journal of Research and Innovation in Social Science, 6*(2), 614-619. doi:10.47772/ijriss.2022.6228

Atoyebi, O. M. (2022). The Link between Mathematics Teaching Strategies and Students' Anxiety. *Asian Journal of Education and Social Studies, 33*(4), 48-57. doi:10.9734/ajess/2022/v33i4716

Babich, B. A. (1996). *http://www.wvadulted.org/cite.html/C.I.T.E. Learning Styles Inventory.* Retrieved Aug 5, 2020, from West Verginia Department of Education.

Babich, B. A. (2003). Instructor Handbook, Section 3, learning styles preferred by students. In *The C.I.T.E. Instrument.* Murdoch Teachers Center in Wichita: WVABE.

Bhatnagar & Saxena. (2000). *Advanced educational psychology.* Meerut: Surya Publications.

Bosman, A. (2018). Learning style preferences and mathematics achievement of secondary school learners. *South African Journal of Education, 38*(1), 1-8. doi:10.15700/saje.v38n1a1440

Bramlett, D., & Herron, S. (2009, Oct. 02). A study of African-American college students' attitude towards mathematics. *Journal of Mathematical Sciences & Mathematics Education*, 43-51. Retrieved Jun 13, 2019

Bursal, M. &. (2006). Mathematics anxiety and pre-service elementary teachers" confidence to teach mathematics and science. School Science and Mathematics. *106(4)* , 173-179. . Retrieved August 21, 2019

Cemen, P. B. (1987). *The nature of mathematics anxiety (Report No. SE048689).* Stillwater: Oklahoma State University. Retrieved August 21, 2019

Chick, Z. (2018). Effect of Motivation, Learning Style and Discipline Learn about Academic Achievement Additional Mathematics. *International Journal of Academic Research in Business and Social Sciences, 8*(4). doi:10.6007/ijarbss/v8-i4/4059

Cimermanová, I. (2018). The effect of learning styles on academic achievement in different forms of teaching. *Cimermanová, Ivana, 11*(3), 219-232. Retrieved November 01, 2018

Ciss. (2019, December 02). *www.ciss.gop/Statistical data*. Retrieved from Teacher's and student's data 2018: http://www.ciss.gop.pk

Cohen, Ibrahim & Allen. (2017). *Detecting Math Anxiety with a Mixture Partial Credit Model.* Georgia, North Amerrica. Retrieved Jun 2019

Cohen, Manion & Morrison. (2007). A Research methods in education.

Cornelius, B. (2019). Two sensory learning styles as predictors of primary school pupils' academic performance in social studies. *European Journal of Social Sciences, 58*(4), 322-335. Retrieved December 01, 2019, from http://www.europeanjournalofsocialsciences.com/

Delima, N. M. (2019). Students' mathematical thinking and their learning style. *Journal of Physics: Conference Series, 1280*(4), 1-8. doi:10.1088/1742-6596/1280/4/042046

Dowker, A. S. (2016, April 7). What Have We Learned in 60 Years ? *Mathematics Anxiety* . doi:org/10.3389/fpsyg.2016.00508

Dunn, R. G. (1995). Meta-Analytic Validation of the Dunn and Dunn Model of Learning-Style Preferences. *The Journal of Educational Research, 88*(06), 353–362. Retrieved from http://www.jstor.org/stable/27541998

Emanet, E. (2021). The effects of student-centered teaching methods used in mathematics courses on mathematics achievement, attitude, and anxiety: a meta-analysis study. *Participatory Educational Research, 8*(2), 240-259. doi:10.17275/PER.21.38.8.2

Fadiana, M. W. (2015). Math Learning Model that Accommodates Cognitive Style to Build Problem-Solving Skills. *Higher Education Studies, 5*(4), 86-98. doi:10.5539/hes.v5n4p86

Fazal-ur-rehman, M. J. (2022). Impact of Mathematics Anxiety on Students ' Academic Achievement in Undergraduate Classes : a Study of Balochistan , Pakistan Syed Impact of Mathematics Anxiety on Students ' Academic Achievement in Undergraduate Classes : a Study of Balochistan , Pakista. *Journal of Jilin University (Engineering and Technology Edition)*(42), 1-9. doi:10.17605/OSF.IO/K5J8W

Forbinger & Fuchs. (2014). : Evidencebased interventions for struggling students. *Rtl in Math*.

Fraenkel, J. R. (2003). *How to Design and Evaluate Research in Education.* New York: McGraw-Hill.

Gates, P., & Vistro-Yu, C. (2003). *Is mathematics for all? , Second International Handbook of Mathematics Education* (Vol. 1). Dordrecht. Retrieved June 2019

Gimba, R. W., Hassan, A. M., Yaki, A. A., & Chado, A. M. (2018). Teachers' and Students' Perceptions on the Problems of Effective Teaching and Learning of Science and Technology in Junior Secondary Schools. *Malaysian Online Journal of Educational Sciences, 6*(1), 34-42. Retrieved July 2019, from www.moj-es.net

Grouws, D. A. (2000). Improving student achievement in mathematics, part 1: research findings. *ERIC Clearinghouse for Science, Mathematics, and Environmental Education, 7469*(217).

Hamidah, K. J. (2022). Learning Analysis with ARIAS Model on Students' Critical Thinking Skills Reviewed from Learning Styles. *AlphaMath : Journal of Mathematics Education, 8*(1), 79-87. doi:10.30595/alphamath.v8i1.13550

Hassan, A. M., Gimba, R. W., & Chado, M. A. (2016). Effect of Information and Communication Technology (ICT) on gender and Achievement of Students in Basic Science and Technology at Junior Secondary School Level. *Computer Education Research Journal (CERJ), 3(1)*, 111-126.

Hirsh, R. A. (2020). Empowering Early Childhood Pre-Service Teachers with Tech Fluency. *Creative Education, 11*(12), 2730-2748. doi:10.4236/ce.2020.1112200

Hodanova, J. N. (2016). Mathematics Importance in Our Life. *INTED2016 Proceedings, 1*, 3086-3092. doi:10.21125/inted.2016.0172

Iqbal, A. (2019, May 1). *BISE Multan*. Retrieved from Board of intermediate and secondary education: http://www.bisemultan.edu.pk/statistical-data-matric

Joswick, C. O. (2022). Mathematics, Learning Disabilities, and Learning Styles: A Review of Perspectives Published by the National Council of Teachers of Mathematics. *Education Sciences, 13*(10), 1-17. doi:10.3390/educsci13101023

Kesici, A. R. (2019). Does Mathematics Anxiety Have Any Impact on Secondary School Pupils' Friend Choices? *International Journal of Educational Methodology, v*(1), 109-116. doi:10.12973/ijem.5.1.123

Khaliq, A. (2016). Effect of Mathematics Anxiety on Punjab Public Secondary School Students ' Mathematics Achievement Effect of Mathematics Anxiety on Punjab Public Secondary School Students ' Mathematics Achievement Introduction Mathematics anxiety is a condition of nervou. *PJERE*, 55-65.

Koonce, D. A. (2011). What is STEM? *koonce2011stem*, (pp. 22-1684).

Kumari. (2015). An investigation into Mathematical Anxiety among students at senior secondary level. *Indian Streams Research Journal, V(VII)*. doi:V(VII). doi: 10.9780/22307850

Laswadi, L. N. (2022). Investigating the effectiveness of using various mathematics learning media among students with various learning styles. *Al-Jabar : Jurnal Pendidikan Matematika, 13*(1), 189-198. doi:10.24042/ajpm.v13i1.12485

Mangi & Hussain . (2018). *Analysis of Mathematics Anxiety among B.Ed. students* (Vol. 8(1)). Human Resource Management Academic Research Society (www.hrmars.com. doi:org/10.6007/IJARBSS/v8-i1/3797

Mangwende, E. M. (2020). Barriers to Mathematics Teachers' Use of Their Knowledge of Students' Learning Styles in Mathematics Teaching: A Case of Secondary Schools in Zimbabwe. *Eurasia Journal of Mathematics, Science and Technology Education*, 1-15. doi:10.29333/ejmste/109198

Margoum, S. L. (2022). Laboratory-Based STEM Education: Micro-computer Based Laboratories and Virtual Laboratories. *1*, 197-209. doi:10.2991/978-2-38476-036-7_19

Mills, N. D. (1992). Not Another Inventory, Rather a Catalyst for Reflection. *o Improve the Academy, 11*, 137. Retrieved Feb 4, 2020

Modebelu, M. N. (2014). Reform-Based-Instructional Method and Learning Styles on Students' Achievement and Retention in Mathematics: Administrative Implications. *International Journal of Education and Literacy Studies, 2*(2), 48-52. doi:10.7575/aiac.ijels.v.2n.2p.48

Morgan, K. (2019). Multisensory Teaching: Crossing Into a New Discipline. *Palaestra, 33*(1), 46-51. Retrieved February 14, 2019, from https://www.scirp.org/journal/ce

Naveed, M. A. (2016). Exploring Information Seeking Anxiety among Research Students in Pakistan. *Libri, 66*(1), 73-82. doi:10.1515/libri-2015-0047

Nepeina, K. N. (2020). The role of field training in stem education: Theoretical and practical limitations of scalability. *European Journal of Investigation in Health, Psychology and Education*(1), 511-529. doi:10.3390/ejihpe10010037

Orhan & Ruhan. (2007). The Effects of Problem-Based Active Learning in Science Education on Students' Academic Achievement, Attitude and Concept Learning. *Eurasia Journal of Mathematics, 3(1)*, 71-81. Retrieved 2019

Orhun, N. (2008,). An investigation into the mathematics achievement and attitude towards mathematics with respect to learning style according to gender. *International Journal of Mathematical Education in Science and Technology, 38*(3), 321-333. doi:10.1080/00207390601116060

Özerem, A. A. (2015). Learning Environments Designed According to Learning Styles and Its Effects on Mathematics Achievement. *Eurasian Journal of Educational Research, 15*(61), 61-80. doi:10.14689/ejer.2015.61.4

Parker Waller, P. a. (2016). Mathematics as a universal language: transcending cultural lines. (parker2016mathematics, Ed.) *{Journal for Multicultural Education, 10*(3), 294-306. Retrieved August 12, 2019

Picciano, A. (2004). *Educational research primer.* A\&C Black.

Preis & Biggs. (2001). Can instructors help learners overcome math anxiety? *Australian Teacher Education Association Journal*, 6-10.

Puteh, M. (2002). Qualitative research approach towards factors associated with mathematics anxiety. Centre of Research in Learning Mathematics,. *Proceeding of the 3rd International Mathematics Education and Society Conference, (MESC'' 02)* (pp. 1-5). Copenhagen: Centre of Research in Learning Mathematics.

Rameli, M., Kosnin, A., Said, H., Tajuddin, H., Karim, N., & Van, N. (2014). Correlational analyses between mathematics anxiety and mathematics achievement among vocational college students. *69 (6)*, 117-120.

Reys, Lindquist, Lambdin & Smith. (2007). *Helping children learn mathematics.* John Wiley & Sons, Inc.

Rizwan & Mahmood. (2010). The Relationship between Test Anxiety and Academic Achievement. *Bulletin of Education and Research, 32*(02), 63-74.

Sheerazi, S. S. (2000). Re-orientation of Mathematics Teaching:An Experimental Study. Ph.D Thesis. *Re-orientation of Mathematics Teaching, 99*, 16-17.

Shrestha, L., & Heisler, E. (2011). The changing demographic profile of the United States. *Institute for Learning Styles Journal* .

Sinaga, S. J. (2022). The Effect of Motivation and Learning Style on Students' Mathematics Learning Achievement. *Jurnal Basicedu, 6*(3), 3554-3562. doi:10.31004/basicedu.v6i3.2669

Suter, L. E. (1991). International Studies of Student Achievement in Mathematics. *Contemporary Psychology: A Journal of Reviews, 36*(10), 872-873.

Swars, S. L. (2006). Mathematics Anxiety and Mathematics Teacher Efficacy: What is the Relationship in Elementary Preservice Teachers? *School Science and Mathematics, 106*(7), 306-315.

Tahir, T. (2021). The Effect of Learning Styles on Students' Mathematical Communication Ability. *Journal of Medives : Journal of Mathematics Education IKIP Veteran Semarang, 5*(1), 13. doi:10.31331/medivesveteran.v5i1.1378

Virgana, V. (2019). Understanding of mathematical concepts through cooperative learning, and learning styles. *Journal of Education and Learning (EduLearn), 13*(2), 212-218. doi:10.11591/edulearn.v13i2.9917